A Status Update for the FLASHFlux Working Group

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Atmospheric Science Data Center Team (SSAI)

CERES FLASHFlux Overview

- ***FLASHFlux Overview***
  - Uses CERES based production system through inversion
  - Periodic calibration updates projected forward; running 3-day TISA
  - LPSA/LPLA SOFA algorithms for surface fluxes
- ***FLASHFlux Latency Objectives***
  - SSF products within 4 days
  - Global 1x1 daily averages from FF TISA; goal: 6-7 days latency
- ***FLASHFlux Usages***
  - Primarily used for applied science and education (i.e., POWER and Globe Clouds)
  - Supports also QC for selected missions (e.g., NOAA NESDIS)
  - TOA gridded fluxes; normalized to TOA EBAF for annual “State of the Climate” assessments (most recent update through August 2021).

FLASHFlux (v4A) SSF Latency Assessment

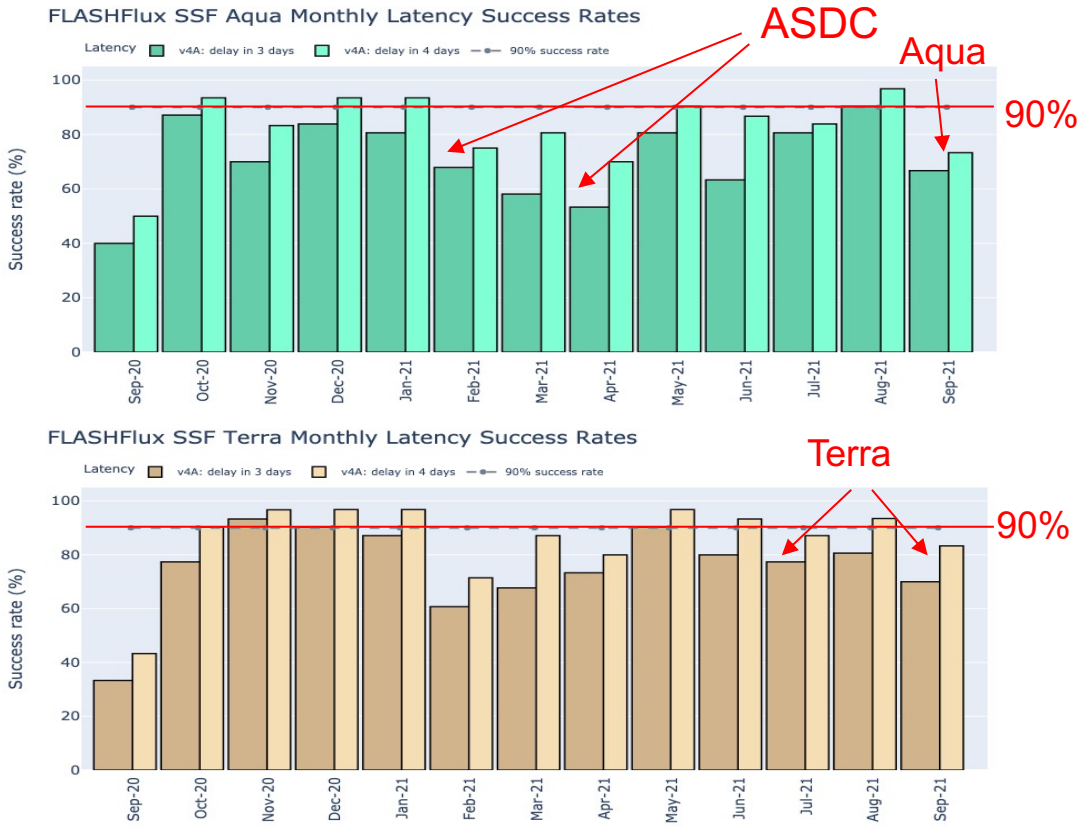
v4A operational in Sep 2020 (delays due to Aqua outage)

Success rate % of time < 3 (dark/thick bar) or 4 days (lighter/thinner bar)

Terra had 7 months at or exceed 90% of days at 4 day latency; Aqua had 5

Lags due to: maneuvers/ satellite issues, ASDC updates/outages

SSF utilized by GLOBE Clouds; occasional satellite algorithm comparisons (i.e., NOAA GOES ABI)



CERES FLASHFlux SSF 4A

Inputs

CERES FF SSF Ver 4A-like
but using specialized combined Gain & Spectral Calibration Coefficients;
geolocated FOVs, etc.

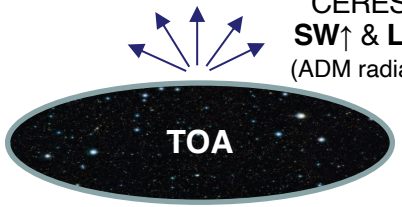
GEOS 5.12.4 (FP-IT)
T(z), p(z), q(z), O_3(z), Ts

MODIS
cloud properties (Ed4)

MATCH
climatological AOD

IGBP surface type

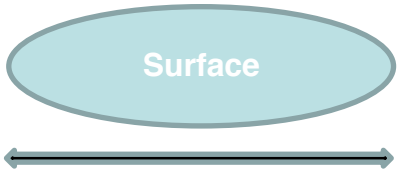
Surface albedo climatological map (clear from TERRA SSF)



CERES derived
SW↑ & **LW↑** fluxes
(ADM radiance to flux)

Parameterized Broadband Surface Fluxes:
e.g., "Model B" - All-Sky
Langley Parameterized Longwave Algorithm
Langley Parameterized Shortwave Algorithm

SW↓↑



LW↓↑

~20-50 km

CERES Footprint / FOV
Terra, Aqua, S-NPP, NOAA-20

Outputs

Instantaneous **broadband** fluxes at the TOA

Instantaneous **broadband** fluxes at the Surface for all-sky and clear (no clouds)

SW up, net; LW up, net

CERES Cloud Radiative Swath (CRS, Beta version)

Inputs

CERES SSF Ed4A
geolocated FOVs, etc.

GEOS 5.4.1
$T(z)$, $p(z)$, $q(z)$, $O_3(z)$
surface wind speed

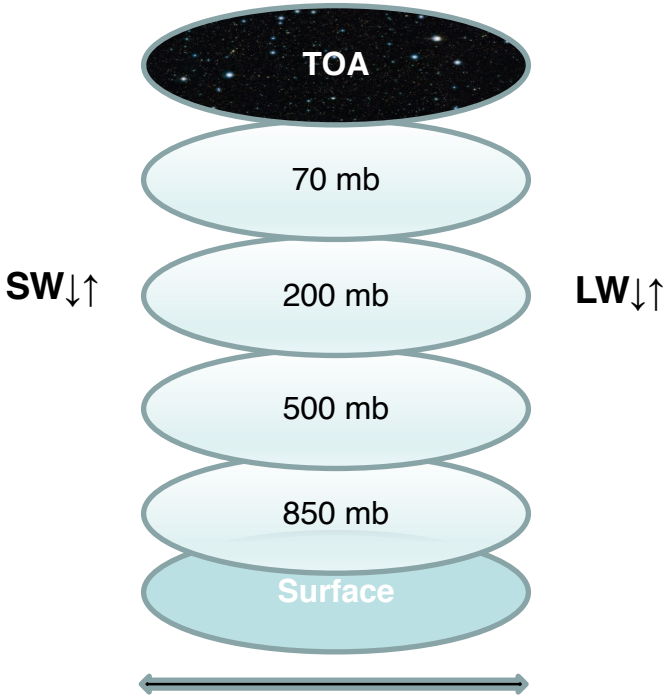
MODIS
cloud properties (Ed4)
spectral albedo
land temp (clear)
AOD (sometimes)

MATCH hourly
aerosol profiles & AOD

IGBP surface type

surface albedo history map (cloudy)

Langley Fu-Liou Radiative Transfer Model



CERES Footprint / FOV
Terra FM1, Aqua FM3

Outputs

instantaneous vertical profiles (6 levels) of **broadband** fluxes + **spectrally-resolved** fluxes at the surface and TOA

4-stream SW
2-stream LW

LW : 12 bands
SW : 14 bands

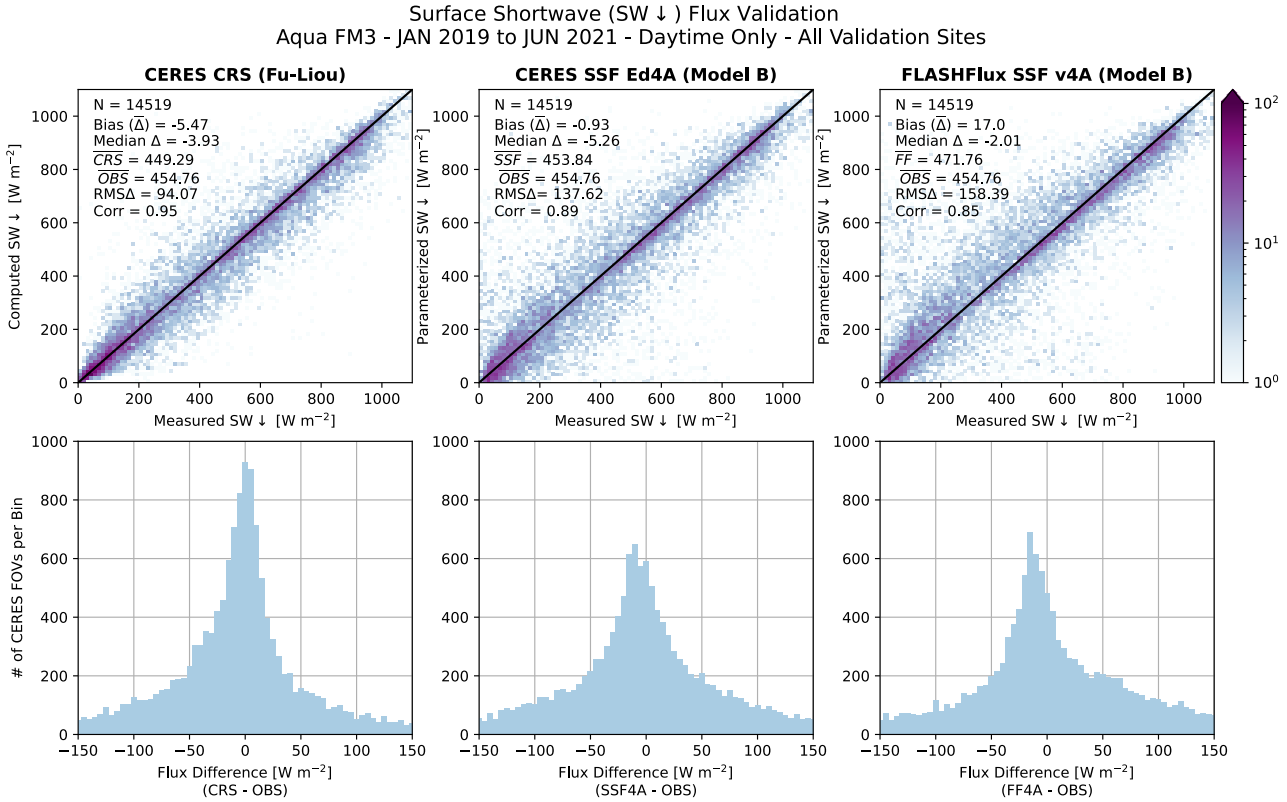
(surface, all-sky)
SW direct + diffuse
PAR, UV fluxes

~ 2,300,000 FOV calculations / day

No longer tuning to the CERES TOA flux
(as in Ed 2)

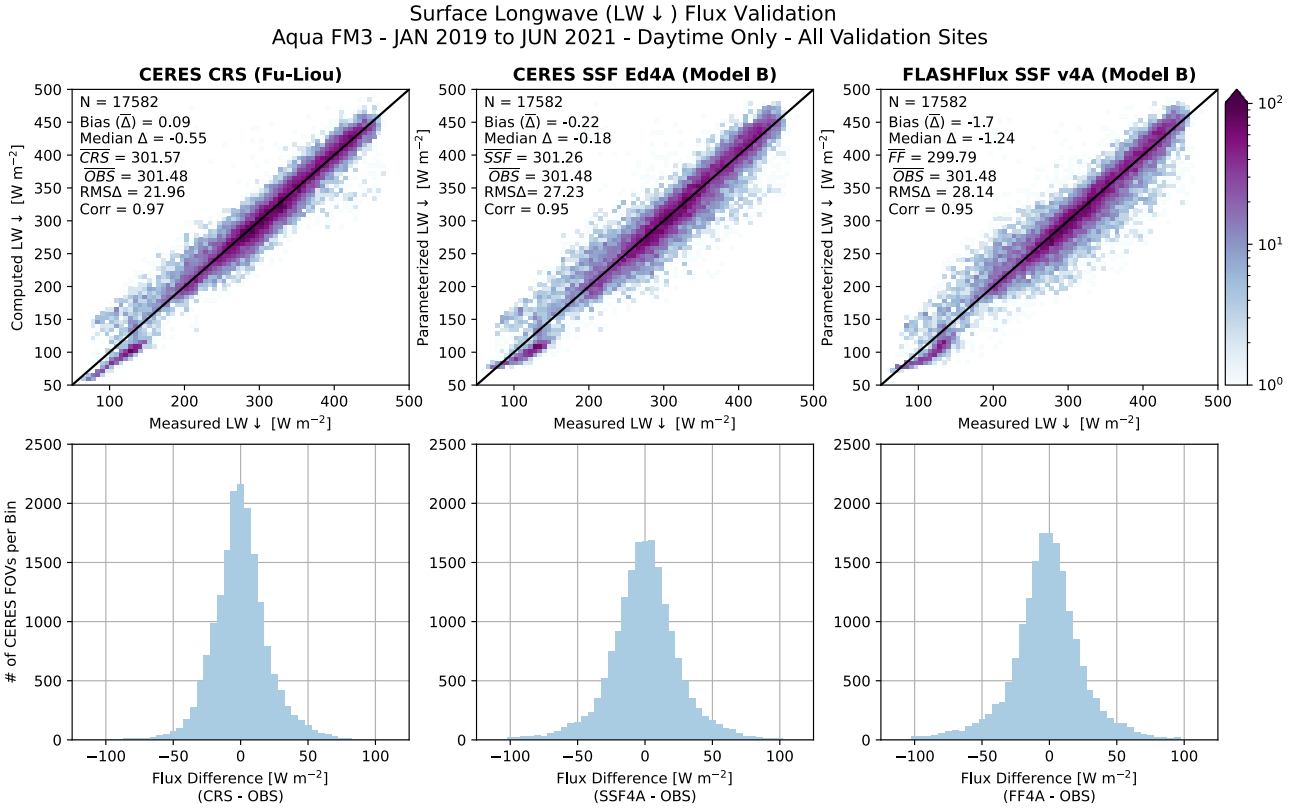
SW Validation vs BSRN Fluxes: CRS and SSF

- Aqua SSF validation for CRS, Ed4A and FF for surface SW down
- CRS consistent outperforms, note RMS differences
- New FF polar flux parameterization appears to explain increased scatter (although works better for TISA)
- Continuing assessment



LW Validation vs BSRN Fluxes: CRS and SSF

- Terra SSF validation for CRS, Ed4A and FF for surface daytime LW down
- Much more consistent than SW, but CRS still has lowest RMS
- Similar results for night-time but larger scatter
- Polar fluxes and show interesting relationships



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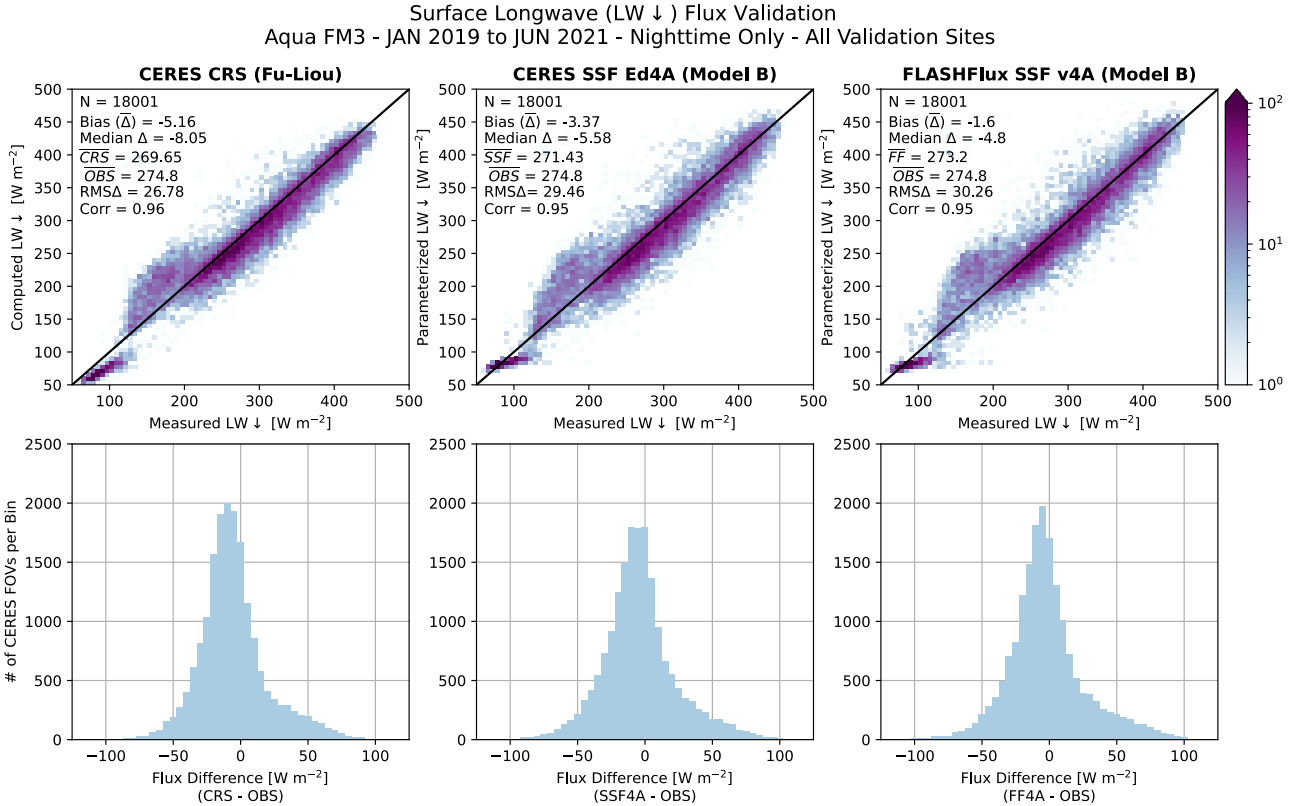
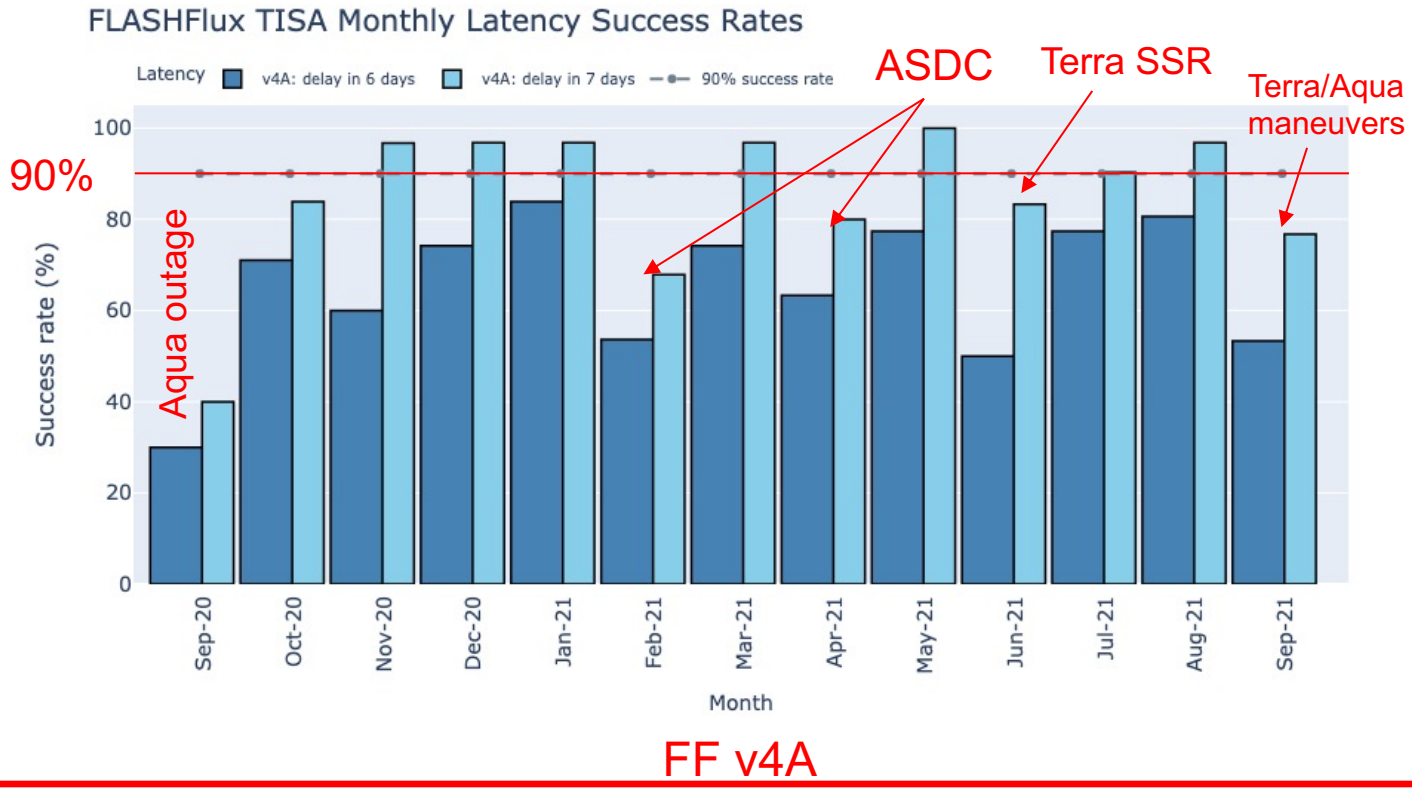


FLASHFlux TISA Latency Assessment



FF v4A

v4A operational in Sep 2020

Success rate % of time < 6 (dark blue) or 7 days (light blue)

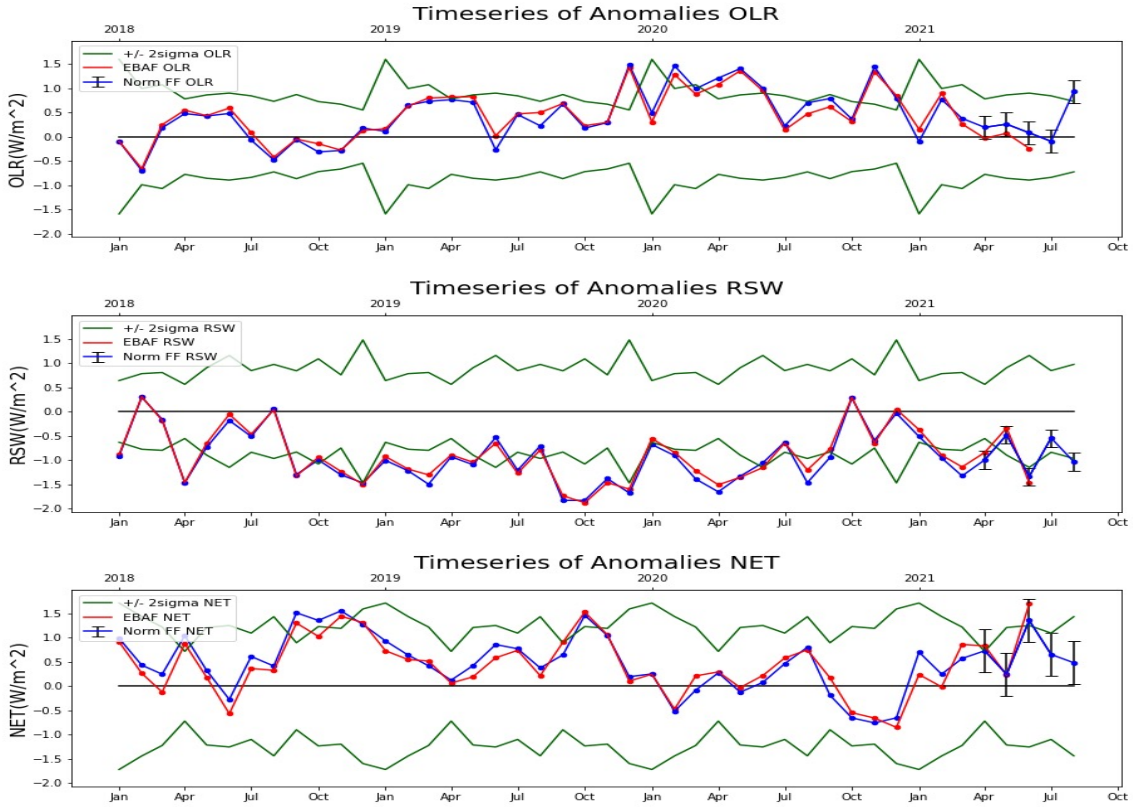
7 of 12 months reached 90% of days at 7 day latency

Lags due to: maneuvers, ASDC updates/outages

TISA delivered to POWER Web Services Suite

EBAF+FF (normalized) TOA Anomalies

- Anomalies relative to July 2005 to June 2015
- Green lines show +/- 2 sigma for each climatological month
- FF Normalized using overlap period begin Jan 2015 and April 2021
- Error bars denoted uncertainty derived from the overlap analysis



FLASHFlux Data Delivery via POWER Web Services Portal (2020/10/01 to 2021/09/30)

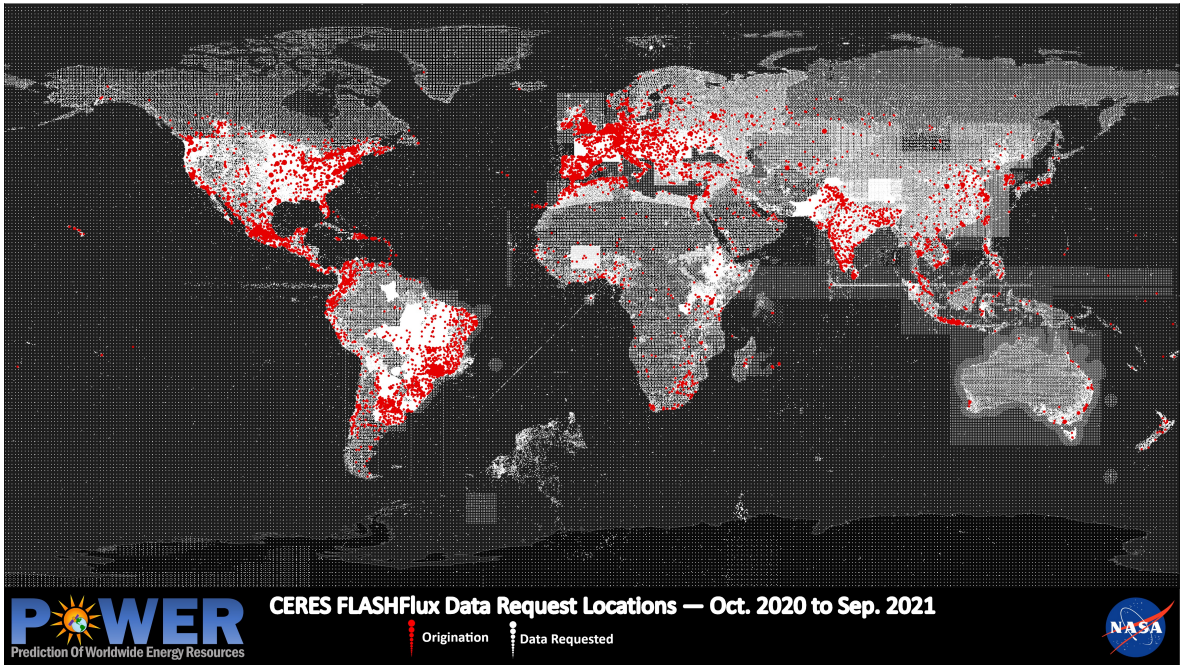
All CERES Orders Delivered via POWER

	Total	Monthly
Unique Users IPs	~94.8 K	~8,992
Requests	~ 35.3 M	~2.95 M

(includes SYN1Deg from Jan 2001 through latest month released)

FLASHFlux Low Latency Orders Delivered via POWER

	Total	Monthly
Unique Users IPs	~28.3 K (30%)	~2,712 (30%)
Requests	~23.1 M (65%)	~1.92 M (65%)



Dot density map showing locations of users (red) and data request locations (white). Brighter colors show larger frequency at that location.

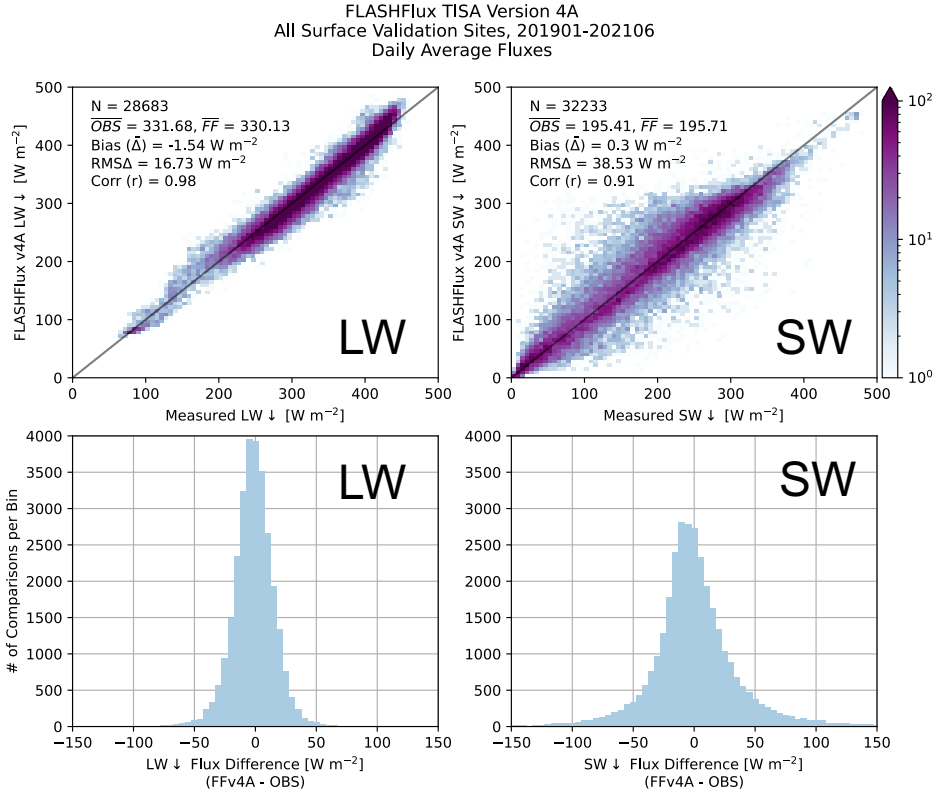
FLASHFlux TISA Validation: BSRN Fluxes

Ensemble FLASHFlux LW and SW Daily Average Comparisons to BSRN Measurements (1/2019-6/2021)

LW: Bias -1.5 W m^{-2}
RMS 16.7 W m^{-2}

SW: Bias 0.3 W m^{-2}
RMS 38.5 W m^{-2}

Histograms show peaked, relatively symmetric distributions, median bias is negative bias for SW, LW

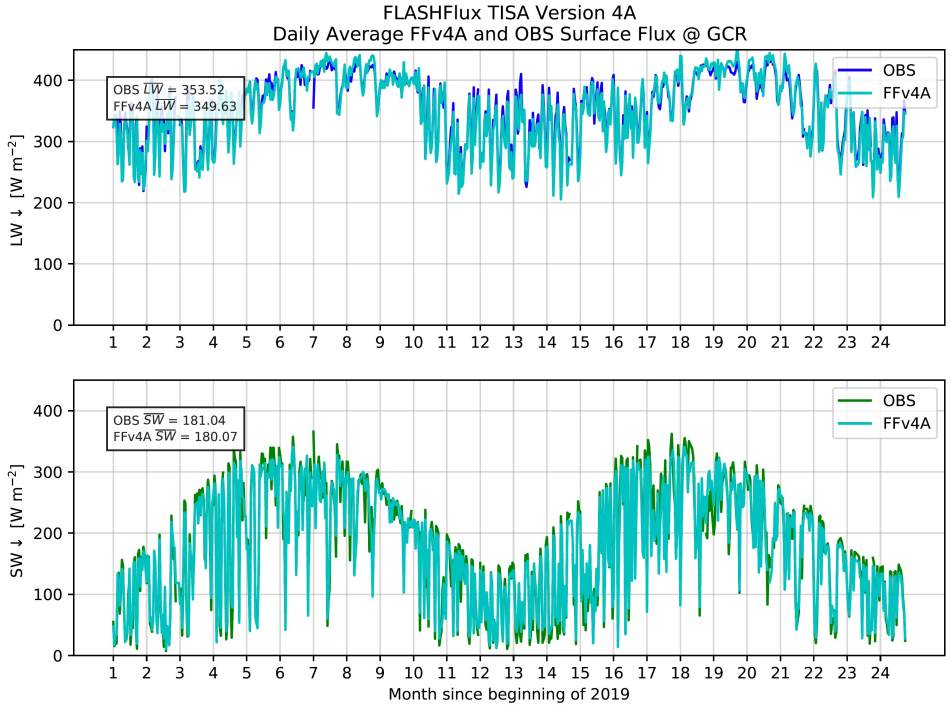


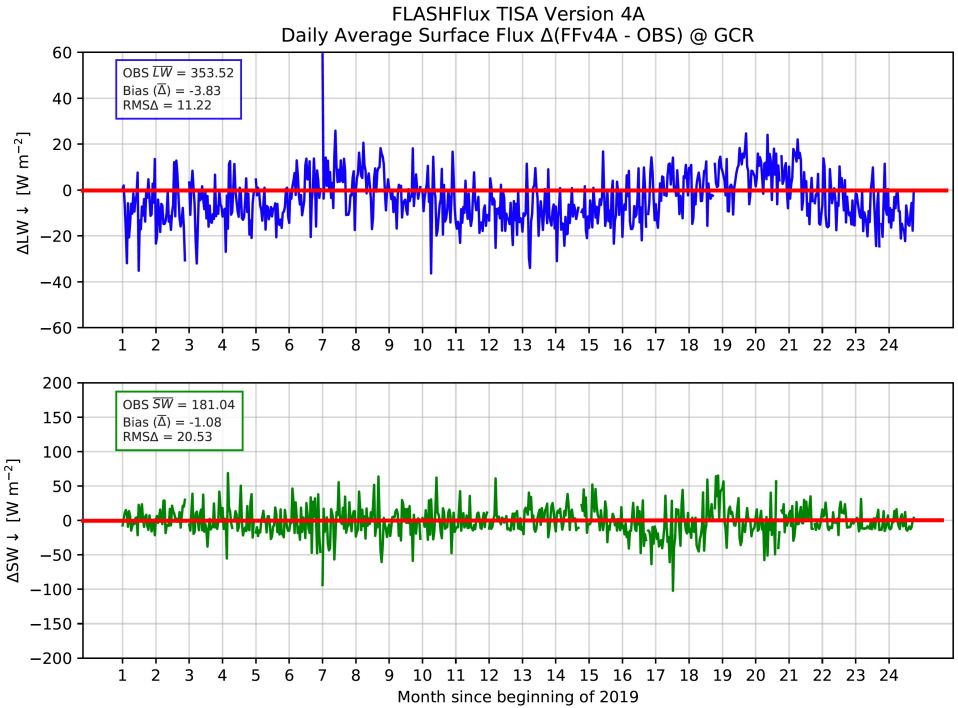
FLASHFlux TISA Validation: BSRN and Ocean Buoy Fluxes

FLASHFlux v4A TISA Daily Average Fluxes (1/2019 – 6/2021)

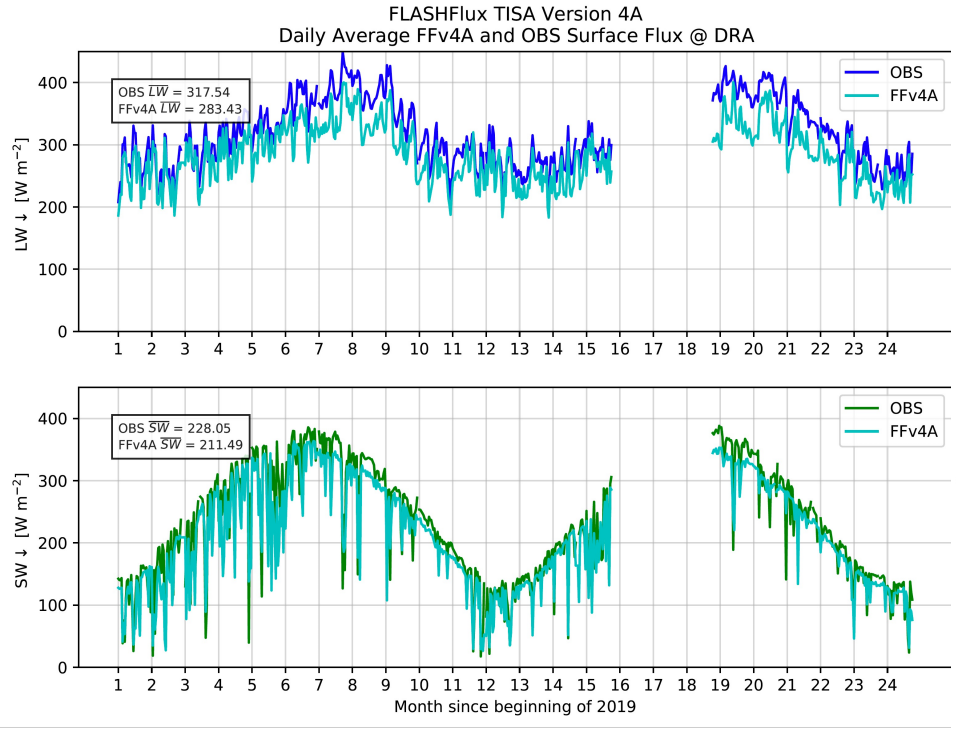
Region Type	LW Bias	LW RMS	# LW Pairs	SW Bias	SW RMS	# SW Pairs
All Ensemble	-1.5	16.7	28,683	0.3	38.5	32,233
Coastal	-0.2	15.7	6369	-1.3	37.0	6164
Desert	-8.5	19.9	2301	-12.3	28.3	2283
Island	6.1	14.7	1935	19.5	47.4	1895
Continental	-4.0	18.0	10053	-4.0	40.3	10002
Polar	0.4	18.8	2989	-8.6	48.4	2028
Ocean buoys	1.0	12.4	5036	6.7	35.7	9861

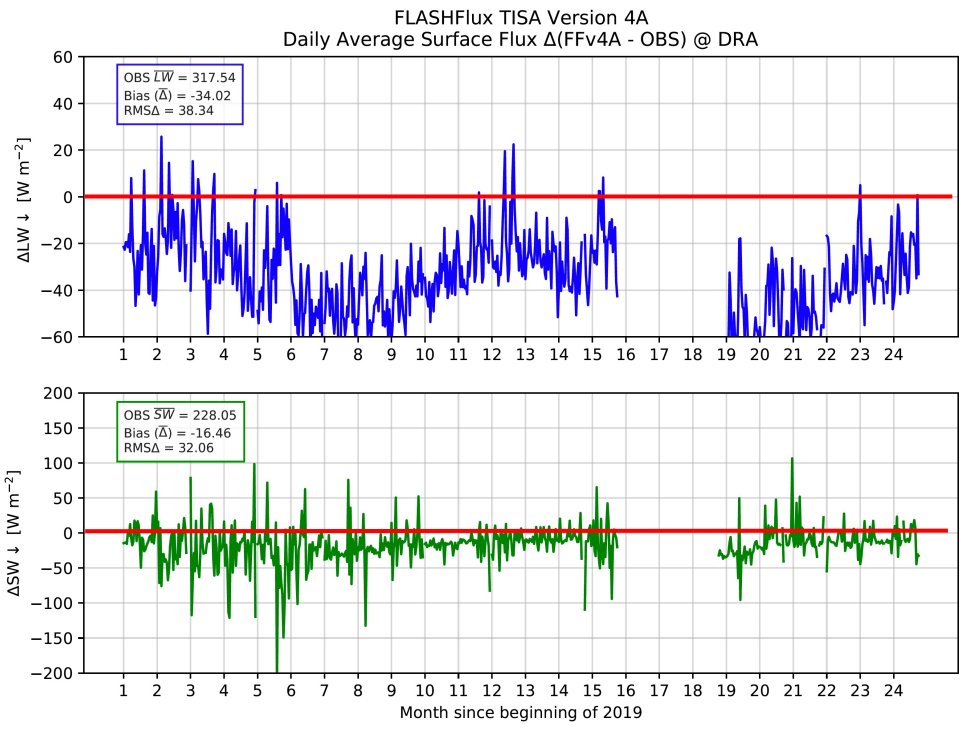
FF Time Series (Goodwin Creek)





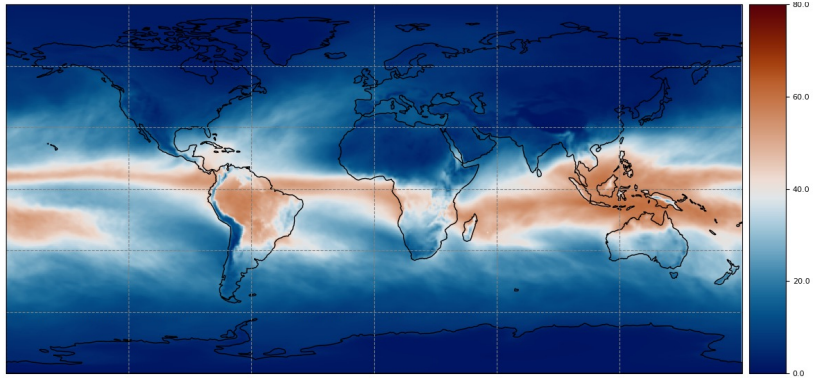
FF Time Series (Desert Rock)



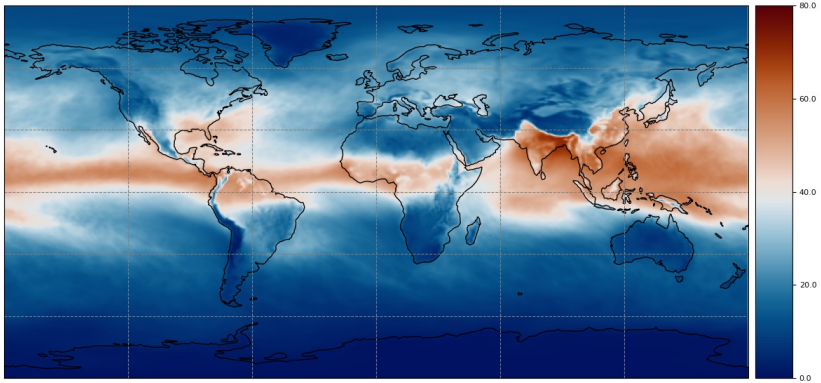


Initial GEOS-IT vs FP-IT Comparisons: PW

GEOS-IT: Mon Avg Precipitable Water (kg m^{-2})

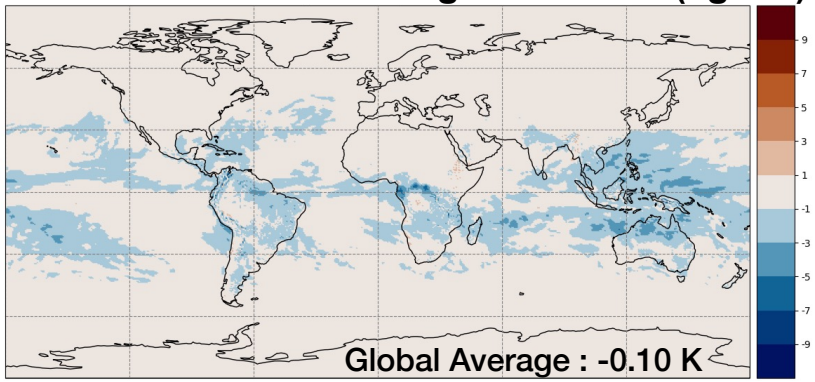


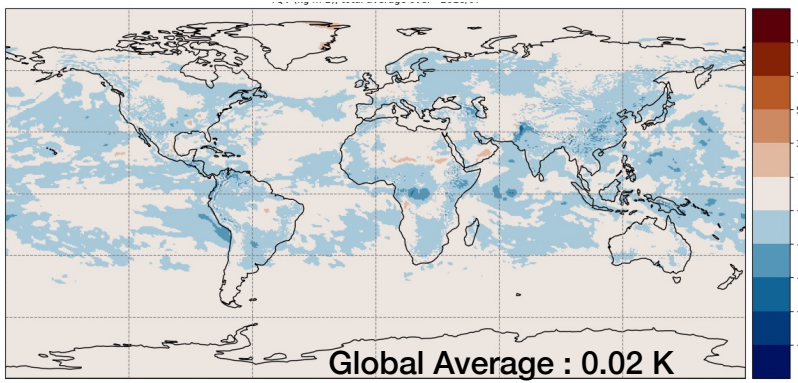
Jan 2018



July 2018

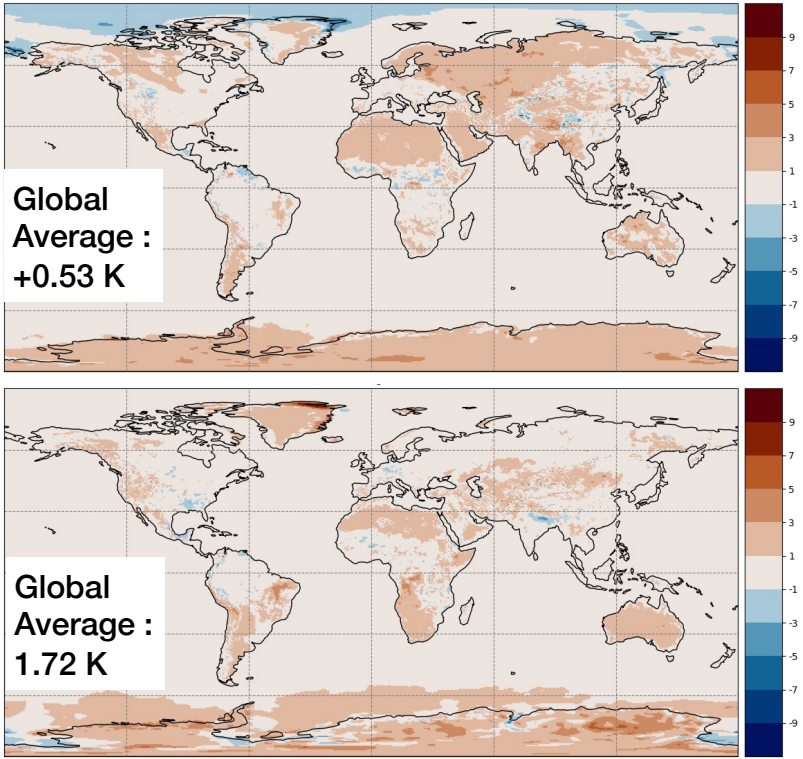
GEOS-IT – FP-IT: Mon Avg Prec Water (kg m^{-2})





Initial GEOS-IT vs FP-IT Comparisons: Tskin

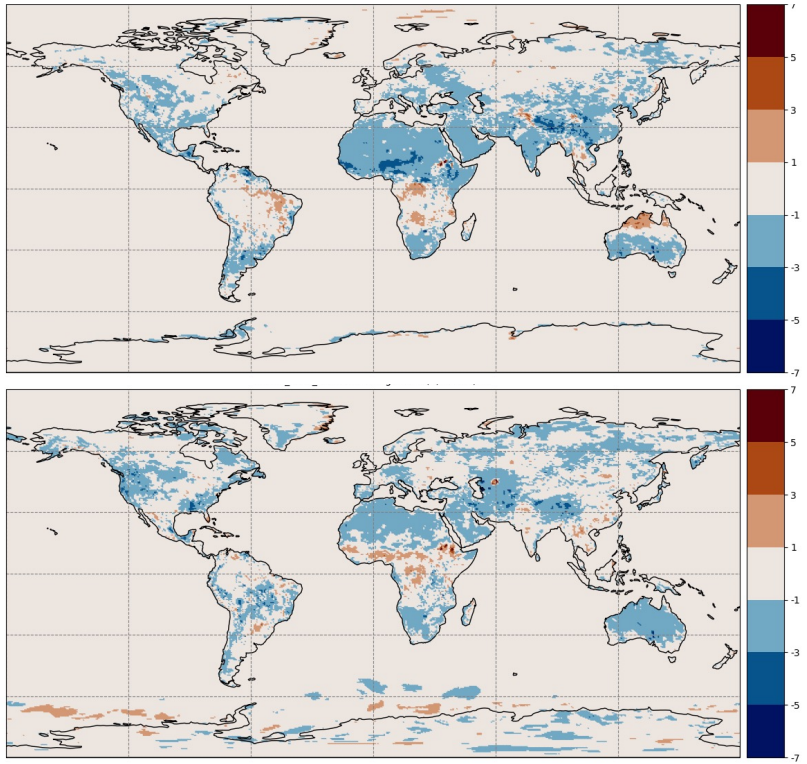
GEOS-IT – FP-IT: Monthly Average T 2m (K)



GEOS-IT – FP-IT: Mon Ave Diurnal Range T 2m (K)

Jan 2018

July 2018



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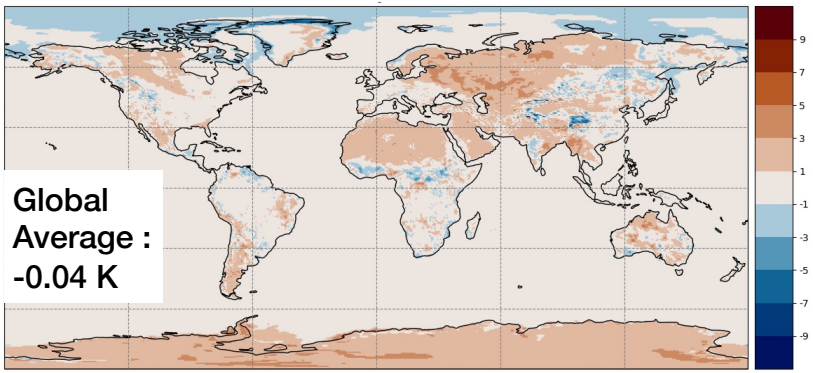
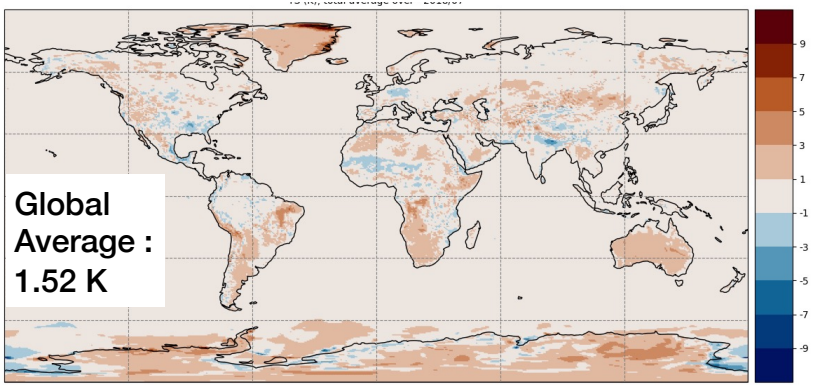
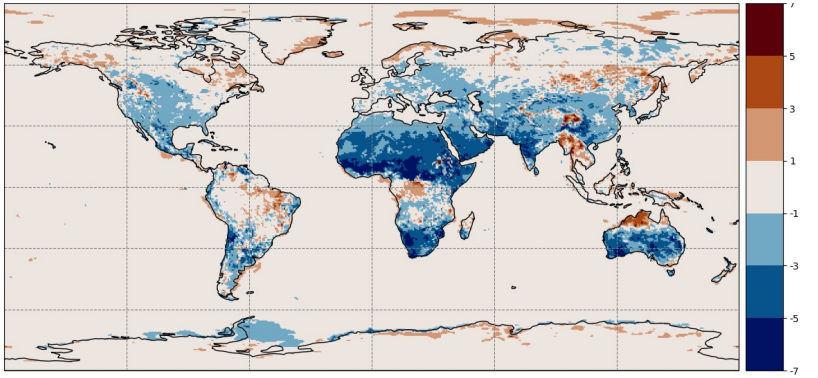
GEOS-IT – FP-IT: Monthly Average Ts (K)





GEOS-IT – FP-IT: Mon Ave Diurnal Range Ts (K)

Jan 2018



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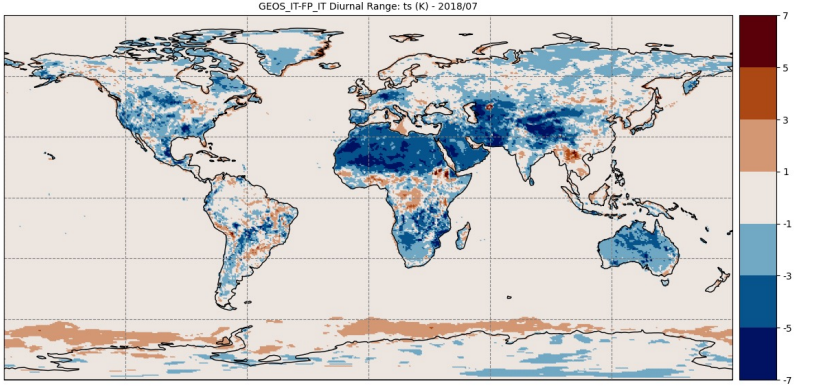

FLASHFlux Summary

- ***Production with v4A Begun (since Aug 1, 2020)***
  - Operational FF v4A SSF and TISA v4A (since Jan 1, 2019): SSF Terra/Aqua through 10/9; TISA through 10/7 (delays in September due to maneuver and missing snow/ice maps all resolved)
  - New FF Gain+Spectral coefficients beginning Oct 1
- ***Validation and Assessment***
  - SSF relative to CRS (Beta), CERES Ed4A SSF (SOFA) and FF and BSRN
  - TISA Daily averages relative to BSRN for Jan 2019 through June 2021 (30 months)
- ***FLASHFlux Modernization and Updates***
  - Migration to CERES CATALYST for future production managing (also see Katie's talk)
  - Evaluating ML based algorithms for future FF SSF data products
  - New GEOS-IT sample data; first cut comparisons to FP-IT (diurnal cycle Ts and T2m changes)
  - NOAA-20 path tested through inversion; upgrading TISA to accommodate
- ***FLASHFlux Information & Data Provision Through ...***
  - Daily and monthly data available in internal subsetter; internal team web site
  - CERES web site and subsetter both SSF and TISA, ASDC (via EarthData) and POWER
    - POWER Distribution in last year: ~94,800 unique IPs; > 35M orders; orders >65% low latency
  - 2020 BAMS State of the Climate TOA Flux report published

FLASHFlux Web Sites

now moved to under CERES page

https://ceres.larc.nasa.gov/data/#fast-longwave-and-shortwave-flux-flashflux

Data also served through
https://power.nasa.gov